

Assessment of risk factors for early childhood caries at different ages and caries levels in Shandong, China and guidance for dental health education: a cross-sectional study

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Abstract

Background Dental health education (DHE) plays a vital role in the prevention of early childhood caries (ECC). There are a large number of studies on ECC risk factor assessment to enrich the content of DHE, but such research rarely provides some guidance and assistance for the design and optimization of DHE strategies. Therefore, this study aims to improve this information by analyzing risk factors at different ages and caries levels. Methods The children aged 3-5-year-old was enrolled in this cross-sectional study. Their oral condition was evaluated according to WHO criteria. Simultaneously, a questionnaire containing the oral health knowledge, attitude, practice (KAP) was completed by guardians. Chi-square test and regression analysis were performed to analyze the ECC difference of KAP variables in different grouping methods, and to construct models to assess the risk factors. Results A total of 1301 children's data were included for statistical analysis. Caries prevalence was 64.6%, the dmft mean was 3.15. Independent associations with increased risk for ECC were age, some KAP variables related to feeding, sugar consumption, and brushing ($P = 0.000$ based on multivariable regression analysis). 3-year-old group were primarily associated with some KA variables ($P = 0.000$). As children grow up, practice variables became the main risk factor (4- and 5-year old age group model: $P = 0.014$ and 0.000). And more practice variables were independently associated with the severe-caries-group than mild-caries-group ($P = 0.000$). Conclusion This survey demonstrates that the ECC-related risk factors in different ages and different caries levels are different, which will facilitate us to design more personalized and strategic DHE content.

Background

Early childhood caries (ECC) mainly refer to the presence of decayed, missing due to caries and filled teeth (dmft) in the oral of children under 71 months [1, 2]. According to the *Lancet* journal statistics, the incidence of deciduous teeth ranks fifth in the world. [3] And it shows a significant negative impact on children's chewing, growth and development [4, 5]. So strengthening the prevention of ECC has always been the most urgent and significant task for dentists and even the whole society. The current prevention of caries is mainly achieved through the following two aspects: i) Professional preventive measures implemented in the hospital: including fluoride coating, pit and fissure sealing, and forth. [6-8]; ii) Self-oral health care (S-OHC) behavior: in addition to brushing, gargle, using gloss to remove the dental plaque, there are also the control of the high-risk factors related to caries such as sugar consumption, feeding habits, etc. [7, 9, 10]. Access to these information is primarily through the dental health education (DHE, covering hospital, school, community and network platforms) [11].

DHE has always been a vital part of the caries prevention [1], which brings intuitive guidance and assistance to people. For children, considering the imperfections in their cognitive level and self-behavior ability, their behavior, habits, consciousness are influenced by the knowledge level, ideology and behavioral habit of the guardian [12, 13]. Therefore, guardians are invited to enter the child's health education system, acting as a good model, guidance and supervision medium, aimed to achieve the purpose of prevention more cost-effectively [14]. However, although there are large number of studies on ECC risk factor assessment currently, which provides a sufficient reference for the establishment of DHE

content, there is almost no research to analyze the risk factors in the different stages of deciduous dentition and different caries levels, which hinders us to design DHE content more specifically and strategically, and then prevent dental caries more effectively.

Therefore, this cross-sectional study intends to base on the analysis of the correlation between the guardian knowledge, attitude and practice (KAP. Practice refers to the OHC behavior of the guardian on the child) and ECC in Shandong, China, obtains the caries-related risk factors, and explores the risk factors at different ages and different caries levels. Summarize these results, further discuss the key content of children's DHE and how to configure DHE details for children of different ages and different caries levels to provide guidance and evidence support for optimizing DHE strategies.

Methods

This cross-sectional study was conducted in 2015-2016 in Shandong province, which was part of the 4th National Oral Health Survey in China, and had been approved by the Ethics Committee of the Chinese Stomatological Association (NO.2014-003).

Sample selection

3-5 year old children lived in Shandong province were our target population. The sample size was determined by the equal allocation of the national plan, 36 children from each age group in each kindergarten were surveyed, so at least 1296 sample data should finally be included in the study. Incorporate sample population according to the following multi-stage stratified sampling method:

1. The probability proportionate to size sampling (PPS) method determined the two districts and two counties for survey.
2. 3 kindergartens were randomly selected from each region
3. Using cluster sampling, 36 children were selected from each age group in each kindergarten.

Examiners selection and training

Three examiners from the Hospital of Stomatology were selected and trained. In order to ensure the consistency of clinical practice inter- and intra- examiners, each examiner randomly enrolled three participants to examinations. Before calculate the Kappa value, every examination results must be calibrated with a qualified examiner. The mean Kappa value of intra-examiners was determined through re-examine the samples, the mean Kappa value of inter-examiners was calculated through mutual examine samples. The clinical practice training would be ended until the Kappa value is greater than 0.8.

Informed consent and questionnaire

After informed all kindergartens enrolled in this research the survey procedure and got support, our team would ask guardians to write informed consent. When the oral examination for children was performing,

a questionnaire would be simultaneously completed by the guardians. The questionnaire contents mainly include:

i) Personal and family information.

ii) OHC knowledge, mainly involved in the effect of brushing, bacteria, sugar, pit and fissure sealing, fluoride and other factors on the teeth and gums.

iii) OHC attitude, mainly to investigate whether the guardian believes that oral health is extremely important.

iv) Guardians-guided OHC practice for children, mainly get information about feeding, eating sugar, brushing, and other habits.

Caries assessment

A ball-end community periodontal index probe was used to assess dental status according to the WHO guidelines[16]. In addition, the written version of the examination results and treatment recommendations would be send to guardians to increase the significance of the survey.

Statistical analysis

The IBM SPSS Statistics version 17.0 was used to perform the statistical analyses. To examine the difference factors between different groups, [Chi-square test](#) or Fisher's test was used for categorical variables, and z test for post hoc comparisons. Ordinal logistic regression analysis and Binary logistic regression analysis were used to perform the multivariable regression analysis. Differences were considered to be significant at $P<0.05$.

In addition, dmft was divided into three groups (dmft=0; dmft=1~3; dmft=4~20) to facilitate statistical analysis. And considering the data for Q7-11 will be available only when the answer to Q6 is 'yes'. Therefore, in multivariable regression analysis based on various grouping ways, the following two sub-models would be separately constructed, sub-model I with all children (n=1301, do not cover Q7-11) and sub-model II only with those children having brushing habits (n=691, covering Q7-11). Furthermore, regression models for each age group and each dmft level were also analyzed. In order to facilitate ordinal regression analysis, we adjusted for education, income, Q21a-f_group, Q21_sum_group, Q22_sum_group (grouping based on the sum of question options), Q3_group, Q4a_group, Q11_group variables.

Results

A total of 3 cities including 2 districts and 2 counties in Shandong were sampled. 1330 preschool children were intended to be invited. However, 18 children's guardians decline to sign the informed consent, 6

questionnaires cover missing information, 5 children transfer to school, so the remaining 1301 children's data were included in the final statistical analysis.

The caries rate (CR) of 3-5-year-old children was 64.6%, and mean dmft was 3.15, the proportion of dmft=2 was as high as 13.2%. The rates of 3, 4, and 5 age group were respectively 51.1%, 67.8%, 73.9%, the mean dmft were 2.16, 3.21, 4.01 (see Table 1). 96.4% of decayed teeth were waiting to be treated.

Difference analysis

The characteristics and difference analysis results of the survey (including demographics and KAP variables) are shown in Table 1-3 and Additional Table S1.

The demographic characteristic shows in Table 1, ECC rates increased with age (51.1% vs 67.8% vs 73.9%, $P=0.000$), whereas no statistical differences were shown in different genders, regions, education background and income.

The distribution characteristic of KAP variables shows in Additional Table S1. 80.9% of the questionnaires were completed by parents and the rest were done by older people, and the CR between them showed no significant difference (data not shown). Analysis from perspective of OHC knowledge (Q22a-h), 66.0%-84.4% of people could correctly answer Q22b-22f, yet only 30.7% known that gum bleeding is not a normal phenomenon when brushing teeth (Q22a), and 16.0% and 27.7% known that fit and fissure sealing or fluoride can protect teeth (Q22g, h). The analysis found that the CR of Q22d, e, g variable show significant difference ($P=0.026, 0.013, 0.030$ respectively), which mainly involve in bacteria and sugar can induce the caries, as well as the pit and fissure sealing can protect teeth. However, after the dmft number was subdivided into two groups, $0 < \text{dmft} \leq 3$ group (Mild, MCG) and $\text{dmft} \geq 4$ group (Severe, SCG), only Q22g showed statistical difference ($P=0.033$). Curiously, among these difference variables, the CR of those who answered incorrectly were lower than those who answered correctly.

Analysis from perspective of OHC attitude (Q21a-f), 81.6%-98.8% of people answer Q21a-e correctly, but only 35.8% believe that the mother's oral health affects the child's oral health (21f). The children raised by those guardians who believe that whether the teeth are health is not related to their own protection unexpectedly have a slightly lower CR than those who do not think so (Q21c, 56.7% vs 66.4%, $P=0.005$). In addition, after respectively summing up the answers to the Q21 and Q22 (named "Q21/Q22_sum_group"), statistics showed that group 1 with high correct rates in Q21_sum_group had higher CR (67.0% vs 61.8%, $P=0.049$).

Analysis from perspective of OHC practices (Q3-11). When infants younger 6 months were fed in different ways, their oral condition would be different (Q3). The CR of the totally artificial feeding subgroup (45%) was significantly lower than other feeding methods ($P=0.005$). In addition, the different frequency and time of eating sweets, the child's caries condition was significantly different (Q4-5). But the difference was only shown in the Q5 about the frequency of eating sugary before going to bed at night, which showed a positive correlation trend with the caries (73.8% vs 66.8% vs 58.6%; $P=0.002$). In Q10, the rates

in children brushing with toothpaste were much higher than those children who do it without toothpaste (65.2% vs 25.0%, $P=0.018$). Similarly, children who brush their teeth with fluoride toothpaste also had higher rates (80.0% vs 68.1% vs 62.2%, $P=0.016$). Children who have frequent toothache or discomfort in the past 12 months (Q12) or who have seen a doctor to the hospital (Q13) usually have a higher caries rate (88.1%-100.0%, 81.0%, $P=0.000$). And the analysis results of Q6-9 showed no statistical difference.

Considering the age was a significant difference variable, we would separately analyze the differences in the distribution of covariates in each age group to eliminate the potential effects of age. Those variables with differences are shown in Table 2. In the 3-year-old group, there was 1 attitude variable (Q21f) and 5 practice variables (Q3_group, Q5, Q11-13) with statistical differences. In the 4-year-old group, gender and 4 practice variables (Q5, Q8, Q12-13) have statistical differences. Among them, those children who didn't brushing daily in Q8 showed the lowest CR in the SCG (18.4%, $P=0.025$). According to further statistics, 66.6% ($n=6$) of these children lived in Linyi district, a place where tough pancakes are the staple food. In the 5-year-old group, 1 knowledge variable (Q22d), 1 attitude variable (Q21c) and 5 practice variables (Q4a, 5, 11-13) have statistical differences. The difference trend of these variables are similar to the results of the overall analysis ($P<0.05$).

Based on the above results, we also found that the difference variables were different in the MCG and SCG. Therefore, a new difference analysis grouped by the degree of caries was implemented (Table 3). In the MCG, there are only 4 difference variables (Q22e, 21c, 3, 12). In the SCG, However, as much as 13 variables have significant difference, including age, Q22d, 22e, 22g, 21b, 21c, 21_sum_group, and Q3, 5, 7, 10-13 ($P<0.05$). All of these variables also showed similar trends to the overall analysis results ($P<0.05$).

Regression analysis

The results of logistic regression analyzes based on the overall, age and the caries level (model 1-3) were shown in Table 4-6. Each model contains two sub-models (I and II).

In the overall analysis model (model 1, Table 4), age, Q22e, g and Q5 variables were the caries risk factors for all children ($P=0.000$), while age, Q21_sum_group and Q11 variables were the risk factors for those children with brushing habits ($P=0.000$). In the analysis model of the 3-5-year-old group (model 2, Table 5), model 2-1 of 3-year-old group reveals that Q21f, 21_sum_group, 22e and Q13 were the risk factors for all kids ($P=0.000$). If we added the Q7-11 variables, the Q22 in the model would lose meaning, so only Q21f, 21_sum_group and Q11 were the risk factors in sub-model II ($P=0.000$). In the model 2-2 of 4-year-old group, only Q5 and Q8, 13 respectively made these two sub-models meaningful ($P=0.014$ and 0.001). The model 2-3 of 5-year-old group showed that Q21c, Q4a, 5, 13 and Q5, 11, 13 were risk factors for these two sub-models, respectively ($P=0.000$). Furthermore, model 3 (Table 6), which grouped based on the caries level, told us that in model 3-1 with mild caries, only age, Q21c and Q3, 12 were risk factors ($P=0.000$). Once the Q7-11 variables were added, the model or variable itself lost statistical significance. While in these severe caries model 3-2, age, Q22e and Q5, 12-13 were caries risk factors for all children ($P=0.000$), and age, Q21b, Q5 and Q11-13 were risk factors for children with brushing habits ($P=0.000$).

Discussion

The present study investigated the city in which the author lived, Shandong province, it's the third largest economic city with GDP in China, has a population of nearly 100 million people. Among them, Linyi city is the city with the largest population and area. And this city has a very special diet, most residents take a hard and tough pancake as their staple food. The other two cities obtained by multi-stage stratified sampling-Weifang and Weihai take the steamed bread as the main food. This combination of multi-stage stratified sampling and cluster sampling not only allows us to obtain samples that represent the oral health status of the province, but also covers areas with different dietary habits. Out of a total of 1330 children aged 3-5-year-old, 1301 families provide complete and reliable data information, the response rate is as high as 97.8%, this is very satisfying.

The CR of 3-5-year-old children in Shandong province is 64.6%, slightly higher than the national data (62.5%), while the dmft mean and the untreated rate of dental caries are lower than the national data (3.15 vs 3.35; 96.4% vs 96.9%)[17]. These data give us an opportunity to analyze the risk factors associated with ECC in Shandong province, and provide targeted theoretical support for the DHE content.

Consistent with most ECC risk assessment studies, age has always been an obvious influencing factor[18], this is also in line with the etiology of dental caries[15]. However, there is little research to assess the risk factors for each age but to evaluate 3-5-year-old children as a whole[19, 20]. So we speculated that although the age span is small, different ages may have different risk factors. As we thought, both the Chi-square test and the corresponding regression model confirm this (Table 2-6). The risk factors for 3-year-old group were mainly KA variables (Q21f, 21_sum_group, 22e, Q13), while the 5-year-old group involved practice variables (Q4a, 5, 13). Practice variables are also mainly associated with serious caries condition (Table 6). In addition, when analyzing sub-models I and II, we found that for all children, knowledge variables and eating sugar habits are high-risk factors, but for children who have already developed brushing habits, attitude variables and brushing habits will become the main risk factors. These results provide a great enlightenment for clinical and oral health education: different advice and education content should be paid on different conditions, this responds to the precision medicine.

Therefore, based on the above analysis, we speculate that Children's DHE should have a system to carry out a series of education guidance, in the early stage of deciduous dentition (3-year-old), the focus should be on enriching the oral health knowledge of guardians, cultivating children's tooth care awareness and habits including the control of some high-risk factors. Considering that children's self-behavioral ability is weak, there is no need to overemphasize whether oral health behavior is criterion. This part is mainly supervised and completed by parents. While with the increase of age, improvement of self-behaviour ability and the development of health habits, whether to master the correct and standardized oral hygiene methods will be transformed into key training content, such as how to properly brush teeth. This part is a key step to bridge the gap between knowledge and practice, which is primarily done by the children themselves.

Furthermore, although the present study obtained some knowledge- and attitude-related risk variables, part of which are negatively correlated with dmft. Some RCTs researches confirmed that the children of guardians who received oral health education usually have lower level of ECC[21, 22], yet some showed no significant effect[23]. This study gave a negative correlation. After precluding the possibility that data entry and statistical methods may be problematic, we speculate that this may be because there is still a gap between the acquisition of KA variables related to OHC and the actual action. After all, the earning of knowledge only gives us an opportunity to improve behavior, but the final behavior is affected by many factors[24]. At the same time, it also reflects that our work in promoting oral health behavior is not enough. Education is only the first step, a lot of work is still needed to bridge the gap.

Brushing has always been considered the primary and most effective way to prevent dental caries. Many studies have confirmed that the frequency and time of brushing affect the occurrence of ECC[25, 26], but more studies have found that they are not relevant[27-29], which is consistent with the results of the present study. This may be because the child's OHC ability is weak, or because the caries lesion of children is more likely to occur in the interproximal[30], while the prevention of interproximal lesions by brushing is restricted, which requires the assistance of interdental cleaning devices to achieve better completion[31]. Regrettably, the role of dental floss in preventing ECC is blank in present study, and research in this area is also limited. Therefore, increasing the information of using dental floss in future research may bring us more outcomes and admonition.

The frequency of eating sweets before going to bed and whether or not to use fluoride toothpaste is the most relevant behavioral risk factors obtained in this study. The positive correlation between the frequency of eating sugar and the caries has been largely confirmed, especially for those sweets before sleeping[25, 32, 33], The children who had sweet snacked twice or more daily had significant higher CR compared to those who snacked less than twice daily[34]. In addition, the function of fluoride in protecting teeth and preventing caries has also been widely confirmed[35-37]. Unfortunately, in present study, only 27.7% of caregivers knew that fluoride could protect teeth. While in order to prevent fluorosis, children under the age of 6 are not recommended to use fluoride toothpaste on their own, but to protect teeth primarily by iatrogenic fluoride[38]. Therefore, the barren of fluoride knowledgemaybe prevent parents from scientifically protecting children's teeth.

What's more, the positive correlation between visiting dentists and dmft indicates that the parents bring children to see doctor only when their teeth have problems. This is contrary to the exhortation for regular inspections to prevent oral problems[39], which also reflects the lack of prevention concepts of parents in Shandong, and this is whereDHE needs to be particularly strengthened.

The limitation of this study: the issues in the OHC knowledge and attitude line designing in this research questionnaire are relatively basic and traditional. Some questions about the impact of proven risk factors on caries andsomemore professionaloral health KAP variables, such as the application of dental floss, are not covered, which has led us to lose the opportunity to assess the impact of these variables on ECC.

Therefore, more information is waiting to be collected to further analyze the correlation between KAP and ECC.

Conclusion

The ECC-related risk factors obtained in this study, such as age, sugar consumption, brushing habits, etc., have been confirmed in previous studies, while a more in-depth analysis brings us some other interesting results: the risk factors for different ages and different levels of caries were different. These results provide some enlightenments for clinical and DHE strategy: in the early stage of deciduous dentition, the focus should be on enriching oral health knowledge of guardians and cultivating children's toothcare habits and awareness. With the increase of age and the gradually formation of self-behavior ability of children, the focus will transfer to the training of correct OHC methods, such as the use of toothbrush and dental floss. Of course, further clinical research is needed to further refine the relevant information and confirm the effectiveness of this strategy.

List Of Abbreviations

ECC: early childhood caries; KAP: knowledge, attitude and practice; OHC: oral health care; DHE: dental health education; WHO: world health organization; dmft: decayed, missing and filled teeth; CR: caries rate; MCG: mild caries group; SCG: serious caries group; RCT: randomized controlled trial; OR: odd rates; CI: confidence interval.

Declarations

Ethics approval and consent to participate: This study had been approved by the Ethics Committee of the Chinese Stomatological Association (NO.2014-003) and the informed consent was obtained from a legal guardian for participants under 16 years old.

Consent for publication: Not applicable.

Availability of data and materials: The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: ZF W, J Land SJ X conceptualized and designed the study, reviewed and revised the manuscript. M Z collected and organized data, carried out the statistical analyses, drafted and revised

the manuscript. Y Z instructed the methods and strategies of statistical analysis, and reviewed and revised the manuscript. XY Z and YN L collected, organized and input data. CC S conducted the statistical analysis of the data. *All authors read and approved the final manuscript.*

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Tables

Table 1. General demographic characteristics of participants and the distribution of dmft.
(n, (%))

Variables	dmft=0	1≤dmft≤3	dmft≥4	<i>P</i>	dmft>0	<i>P</i>
Gender						
male	235(36.1)	184(28.3)	232(35.6)	0.270	416(63.9)	0.616
female	226(34.8)	210(32.3)	214(32.9)		424(65.2)	
Age						
3	203(48.9) ^a	113(27.2) ^a	99(23.9) ^a	0.000	212(51.1) [*]	0.000
4	142(32.2) ^b	153(34.7) ^a	146(33.1) ^b		299(67.8) ^{**}	
5	116(26.1) ^b	128(28.8) ^a	201(45.2) ^c		329(73.9) ^{***}	
Region						
urban	227(34.9)	202(31.0)	222(34.1)	0.245	424(65.1)	0.343
weihai	111(34.3)	94(29.0)	119(36.7)		213(65.7)	
hedong, linyi	116(35.5)	108(33.0)	103(31.5)		211(64.5)	
rural	234(36.0)	192(29.5)	224(34.5)		416(64.0)	
weifang	106(32.7)	93(28.7)	125(38.6)		218(67.3)	
pingyi, linyi	128(39.3)	99(30.4)	99(30.4)		198(60.7)	
Education						
Elementary school and below	88(34.9)	75(29.8)	89(35.3)	0.807	164(19.5)	0.699
junior high school	192(36.8)	150(28.7)	180(34.5)		330(39.3)	
Senior high school and above	181(34.3)	169(32.1)	177(33.6)		346(41.2)	
Income						
less than 30,000	111(34.0)	100(30.7)	115(35.3)	0.133	215(27.4)	0.357
40,000-60,000	166(38.0)	111(25.4)	160(36.6)		271(34.5)	
more than 70,000	153(33.8)	151(33.3)	149(32.9)		300(38.2)	

^a, ^b, ^c: Differences in caries rate between row variables in subgroups with different levels of caries, the same mark represents no difference between the two variables.

^{*}, ^{**}, ^{***}: The difference in caries rates between row variables, the same mark represents no difference between the two variables.

Table 2. Differential KAP variables in different age groups. (n, (%))

Groups and variables	dmft=0	1≤dmft≤3	dmft≥4	P
For 3-year-old group (n=415)				
Attitude				
Q21f_group Does the mother's unhealthy teeth affect the child's teeth?				
correct answer	82(54.7) ^a	43(28.7) ^a	25(16.7) ^a	0.032
wrong answer	121(45.7) ^a	70(26.4) ^a	74(27.9) ^b	
Practice				
Q3_group Feeding method within 6 months of birth				
complete or mainly breastfeeding	156(46.8) ^a	97(29.1) ^a	80(24.0) ^a	0.016
complete or mainly artificial feeding	32(71.1) ^b	7(15.6) ^a	6(13.3) ^a	
half breastfeeding and half artificial feeding	15(40.5) ^a	9(24.3) ^a	13(35.1) ^a	
Q5 Frequency of eating sweet before going to bed at night				
often	13(36.1) ^a	15(41.7) ^a	8(22.2) ^{a, b}	0.030
occasionally	118(47.0) ^a	63(25.1) ^a	70(27.9) ^b	
never	72(56.3) ^a	35(27.3) ^a	21(16.4) ^a	
Q11 Whether to use fluoride toothpaste				
Yes	3(21.4) ^a	5(35.7) ^a	6(42.9) ^a	0.023
No	17(39.5) ^{a, b}	11(25.6) ^a	15(34.9) ^a	
do not know	71(56.8) ^b	32(25.6) ^a	22(17.6) ^a	
Q12 Has your child had a toothache or discomfort in the past 12 months?				
Never	179(54.4) ^a	88(26.7) ^a	62(18.8) ^a	0.000
Sometimes	11(18.0) ^b	21(34.4) ^a	29(47.5) ^b	
Often	0(0) ^{a, b}	1(25.0) ^a	3(75.0) ^b	
Not clear	13(61.9) ^a	3(14.3) ^a	5(23.8) ^{a, b}	
Q13 Did your child go to the hospital to see the teeth?				
Yes	24(35.8) ^a	17(25.4) ^a	26(38.8) ^a	0.006
Never	179(51.4) ^b	96(27.6) ^a	73(21.0) ^b	
For 4-year-old group (n=441)				
Gender				
male	81(37.5) ^a	64(29.6) ^a	71(32.9) ^a	0.033
female	61(27.1) ^b	89(39.6) ^b	75(33.3) ^a	
Practice				
Q5 Frequency of eating sweet before going to bed at night				
often	10(29.4) ^a	5(14.7) ^a	19(55.9) ^a	0.004
occasionally	78(30.2) ^a	89(34.5) ^{a, b}	91(35.3) ^{a, b}	
never	54(36.2) ^a	59(39.6) ^b	36(24.1) ^b	
Q8 Brushing times per day				
2 times and above	12(25.5) ^a	12(25.5) ^a	23(48.9) ^a	0.025
1 time	44(30.3) ^a	52(35.9) ^a	49(33.8) ^{a, b}	
not daily brush	22(44.9) ^a	18(36.7) ^a	9(18.4) ^b	
Q12 Has your child had a toothache or discomfort in the past 12 months?				
Never	130(38.2) ^a	129(37.9) ^a	81(23.8) ^a	0.000
Sometimes				

	10(13.5) ^b	17(23.0) ^a	47(63.5) ^b	
Often	0(0) ^b	3(23.1) ^a	10(76.9) ^b	
Not clear	2(14.3) ^{a, b}	4(28.6) ^a	8(57.1) ^b	
Q13 Did your child go to the hospital to see the teeth?				
Yes	14(18.4) ^a	15(19.7) ^a	47(61.8) ^a	0.000
Never	128(35.1) ^b	138(37.8) ^b	99(27.1) ^b	
For 5-year-old group (n=445)				
Knowledge				
Q22d Can bacteria cause dental caries?				
correct answer	79(25.0) ^a	91(28.8) ^{a, b}	146(46.2) ^a	0.036
wrong answer	9(60.0) ^b	1(6.7) ^b	5(33.3) ^a	
don not know	28(24.6) ^a	36(31.6) ^a	50(43.9) ^a	
Attitude				
Q21c_group Is the quality of your teeth related to your own protection?				
correct answer	88(24.2) ^a	100(27.5) ^a	175(48.2) ^a	0.023
wrong answer	28(34.1) ^a	28(34.1) ^a	26(31.7) ^b	
Practice				
Q4a Frequency of eating sweet food				
rare/never	37(35.6) ^a	32(30.8) ^a	35(33.7) ^a	0.014
1-3 times/month	20(28.6) ^a	20(28.6) ^a	30(42.9) ^{a, b}	
1 time/week	17(28.3) ^a	22(36.7) ^a	21(35.0) ^a	
2-6 times/week	25(22.5) ^a	31(27.9) ^a	55(49.5) ^{a, b}	
1 time/day	11(18.6) ^a	16(27.1) ^a	32(54.2) ^{a, b}	
≥2 times/day	6(14.6) ^a	7(17.1) ^a	28(68.3) ^b	
Q5 Frequency of eating sweet before going to bed at night				
often	4(12.1) ^a	7(21.2) ^a	22(66.7) ^a	0.002
occasionally	56(22.5) ^a	71(28.5) ^a	122(49.0) ^a	
never	56(34.4) ^b	50(30.7) ^a	57(35.0) ^b	
Q11 Whether to use fluoride toothpaste				
Yes	2(9.1) ^a	3(13.6) ^a	17(77.3) ^a	0.038
No	20(31.7) ^b	17(27.0) ^a	26(41.3) ^b	
do not know	47(26.7) ^{a, b}	52(29.5) ^a	77(43.8) ^b	
Q12 Has your child had a toothache or discomfort in the past 12 months?				
Never	102(35.3) ^a	93(32.2) ^a	94(32.5) ^a	0.000
Sometimes	10(7.9) ^b	29(23.0) ^a	87(69.0) ^{b, c}	
Often	0(0) ^b	1(6.7) ^a	14(93.3) ^c	
Not clear	4(26.7) ^{a, b}	5(33.3) ^a	6(40.0) ^{a, b}	
Q13 Did your child go to the hospital to see the teeth?				
Yes	9(8.7) ^a	25(24.0) ^a	70(67.3) ^a	0.000

Never

107(31.4)^b 103(30.2)^a 131(38.4)^b

a, b, c: Differences in caries rate between row variables in subgroups with different levels of caries, the same mark represents no difference between the two variables.

Table 3. Differential KAP variables in different levels of caries. (n, (%))

For mild caries group (1 ≤ dmft ≤ 3, n=394)					
Knowledge					
Q22e_group	Does eating sugar cause dental caries?				
	correct answer	371(52.3) ^a	339(47.7) ^a	-	0.031
	wrong answer or do not know	90(62.1) ^b	55(37.9) ^b	-	
Attitude					
Q21c_group	Is the quality of your teeth related to your own protection?				
	correct answer	357(52.0) ^a	329(48.0) ^a	-	0.027
	wrong answer	104(61.5) ^b	65(38.5) ^b	-	
Practice					
Q3_group	Feeding method within 6 months of birth				
	complete or mainly breastfeeding	344(51.7) ^a	322(48.3) ^a	-	0.013
	complete or primary artificial feeding	66(67.3) ^b	32(32.7) ^b	-	
	half breastfeeding and half artificial feeding	51(56.0) ^{a, b}	40(44.0) ^{a, b}	-	
Q12	Has your child had a toothache or discomfort in the past 12 months?				
	Never	411(57.0) ^a	310(43.0) ^a		0.000
	Sometimes	31(31.6) ^b	67(68.4) ^b		
	Often	0(0) ^{a, b}	5(100.0) ^{a, b}		
	Not clear	19(61.3) ^a	12(38.7) ^a		
For severe caries group (dmft ≥ 4, n=446)					
age					
	3	203(67.2) ^a	-	99(32.8) ^a	0.000
	4	142(49.3) ^b	-	146(50.7) ^b	
	5	116(36.6) ^c	-	201(63.4) ^c	
Knowledge					
Q22d	Can bacteria cause dental caries?				
	correct answer	328(50.3) ^a	-	324(49.7) ^a	0.043
	wrong answer	28(70.0) ^b	-	12(30.0) ^b	
	don not know	105(48.8) ^a	-	110(51.2) ^a	
Q22e_group	Does eating sugar cause dental caries?				
	correct answer	371(48.9) ^a	-	388(51.1) ^a	0.008
	wrong answer or do not know	90(60.8) ^b	-	58(39.2) ^b	
Q22g	Can the pit and fissure sealing prevent dental caries?				
	correct answer	60(40.3) ^a	-	89(59.7) ^a	0.011
	wrong answer	29(60.4) ^b	-	19(39.6) ^b	
	don not know	372(52.4) ^b	-	338(47.6) ^b	
Attitude					
Q21b_group	Is regular oral examination necessary?				
	correct answer	421(49.8) ^a	-	424(50.2) ^a	0.025
	wrong answer	40(64.5) ^b	-	22(35.5) ^b	
Q21c_group	Is the quality of your teeth related to your own protection?				
	correct answer	357(48.8) ^a	-	375(51.2) ^a	0.011
	wrong answer	104(59.4) ^b	-	71(40.6) ^b	

21_sum_group				
1 group(6-7 scores)	229(47.7) ^a	-	251(52.3) ^a	0.046
2 group(8-54 scores)	232(54.3) ^b	-	195(45.7) ^b	
Practice				
Q3 Feeding method within 6 months of birth				
complete breastfeeding	256(49.3) ^a	-	263(50.7) ^a	0.006
mainly breastfeeding	88(49.7) ^a	-	89(50.3) ^a	
complete artificial feeding	44(74.6) ^b	-	15(25.4) ^b	
mainly artificial feeding	22(48.9) ^{a, b}	-	23(51.1) ^{a, b}	
half breastfeeding and half artificial feeding	51(47.7) ^a	-	56(52.3) ^a	
Q5 Frequency of eating sweet before going to bed at night				
often	27(35.5) ^a	-	49(64.5) ^a	0.000
occasionally	252(47.1) ^a	-	283(52.9) ^a	
never	182(61.5) ^b	-	114(38.5) ^b	
Q7 Age at which to start brushing				
half year old	1(25.0) ^a	-	3(75.0) ^a	0.016
1 year old	9(56.3) ^a	-	7(43.8) ^a	
2 years old	73(58.4) ^a	-	52(41.6) ^a	
3 years old	127(50.8) ^a	-	123(49.2) ^a	
4 years old	27(37.0) ^a	-	46(63.0) ^a	
5 years old	4(25.0) ^a	-	12(75.0) ^a	
do not remember	3(75.0) ^a	-	1(25.0) ^a	
Q10_group Whether to use toothpaste				
Yes	238(49.4) ^a	-	244(50.6) ^a	0.030
No or do not know	6(100) ^b	-	0(0) ^b	
Q11 Whether to use fluoride toothpaste				
Yes	12(28.6) ^a	-	30(71.4) ^a	0.004
No	52(44.4) ^{a, b}	-	65(55.6) ^{a, b}	
do not know	174(53.9) ^b	-	149(46.1) ^b	
Q12 Has your child had a toothache or discomfort in the past 12 months?				
Never	411(63.4) ^a	-	237(36.6) ^a	0.000
Sometimes	31(16.0) ^b	-	163(84.0) ^b	
Often	0(0) ^b	-	27(100.0) ^b	
Not clear	19(50.0) ^a	-	19(50.0) ^a	
Q13 Did your child go to the hospital to see the teeth?				
Yes	47(24.7) ^a	-	143(75.3) ^a	0.000
Never	414(57.7) ^b	-	303(42.3) ^b	

^a, ^b: Differences in caries rate between row variables in subgroups with different levels of caries, the same mark represents no difference between the two variables.

Table 4. Multivariable logistic regression model for overall. (Ordinal logistic regression analysis)

model 1							
all kids (sub-model I)				only kids with brushing habits (sub-model II)			
Variables	<i>P</i>	OR	95% CI	Variables	<i>P</i>	OR	95% CI
age				Age			
3 years old	0.000	0.35	0.27-0.45	3 years old	0.000	0.34	0.24-0.49
4 years old	0.001	0.65	0.51-0.83	4 years old	0.009	0.65	0.47-0.90
5 years old	NA	1.00	NA	5 years old	NA	1.00	NA
22e_group Does eating sugar cause dental caries?				21_sum_group			
Yes	0.022	1.39	1.05-1.85	1 group(6-7 scores)	0.021	1.40	1.05-1.85
No or do not know	NA	1.00	NA	2 group(8-54 scores)	NA	1.00	NA
22g_group Can the pit and fissure sealing prevent dental caries?				11_group Whether to use fluoride toothpaste			
Yes	0.014	1.42	1.08-1.88	Yes	0.009	1.98	1.19-3.31
No or do not know	NA	1.00	NA	No or do not know	NA	1.00	NA
Q5 Frequency of eating sweet before going to bed at night							
often	0.000	2.55	1.70-3.83				
occasionally	0.000	1.58	1.27-1.97				
never	NA	1.00	NA				

OR: odd rates; CI: confidence interval; NA: not applicable.

Table 5. Multivariable logistic regression model for different age groups. (Ordinal logistic regression analysis)

model 2-1 (For 3-year-old group) all kids (sub-model I)				only kids with brushing habits (sub-model II)			
Variables	<i>P</i>	OR	95% CI	Variables	<i>P</i>	OR	95% CI
21f_group Does the mother's unhealthy teeth affect the child's teeth?				21f_group Does the mother's unhealthy teeth affect the child's teeth?			
Yes	0.001	0.47	0.31-0.73	Yes	0.002	0.35	0.18-0.69
No or do not know	NA	1.00	NA	No or do not know	NA	1.00	NA
21_sum_group				21_sum_group			
1 group(6-7 scores)	0.010	1.71	1.14-2.58	1 group(6-7 scores)	0.000	3.53	1.84-6.76
2 group(8-54 scores)	NA	1.00	NA	2 group(8-54 scores)	NA	1.00	NA
22e_group Does eating sugar cause dental caries?				Q11_group Whether to use fluoride toothpaste			
Yes	0.022	1.84	1.09-3.11	Yes	0.085	2.58	0.88-7.56
No or do not know	NA	1.00	NA	No or do not know	NA	1.00	NA
Q13 Did your child go to the hospital to see the teeth?							
Yes	0.003	2.13	1.30-3.49				
Never	NA	1.00	NA				
model 2-2 (For 4-year-old group) all kids (sub-model I)				only kids with brushing habits (sub-model II)			
Variables	<i>P</i>	OR	95% CI	Variables	<i>P</i>	OR	95% CI
Q5 Frequency of eating sweet before going to bed at night				Q8 Brushing times per day			
often	0.006	2.66	1.32-5.38	2 times and above	0.004	3.09	1.44-6.60
occasionally	0.044	1.47	1.01-2.13	1 time	0.033	1.94	1.06-3.57
never	NA	1.00	NA	not daily brush	NA	1.00	NA
				Q13 Did your child go to the hospital to see the teeth?			
				Yes	0.005	2.38	1.29-4.39
				Never	NA	1.00	NA
model 2-3 (For 5-year-old group) all kids (sub-model I)				only kids with brushing habits (sub-model II)			
Variables	<i>P</i>	OR	95% CI	Variables	<i>P</i>	OR	95% CI
Q4a_group Frequency of eating sweet food				Q5 Frequency of eating sweet before going to bed at night			
≤1 time/week	0.001	0.55	0.38-0.79	often	0.018	3.88	1.26-11.89
≥2 times/week	NA	1.00	NA	occasionally	0.010	1.89	1.16-3.08
				never	NA	1.00	NA
Q5 Frequency of eating sweet before going to bed at night				Q11_group Whether to use fluoride toothpaste			

often	0.020	2.59	1.16-5.76	Yes	0.006	4.32	1.53-12.16
occasionally	0.009	1.66	1.13-2.42	No or do not know	NA	1.00	NA
never	NA	1.00	NA				
Q13 Did your child go to the hospital to see the teeth?				Q13 Did your child go to the hospital to see the teeth?			
Yes	0.000	3.62	2.28-5.77	Yes	0.000	2.95	1.71-5.08
Never	NA	1.00	NA	Never	NA	1.00	NA

OR: odd rates; CI: confidence interval; NA: not applicable.

Table 6. Multivariable logistic regression model for different levels of caries. (Binary logistic regression analysis)

model 3-1 (For children with 1-3 dmft (MCG))							
all kids (sub-model I)				only kids with brushing habits (sub-model II)			
Variables	<i>P</i>	OR	95% CI	Variables	<i>P</i>	OR	95% CI
age	0.000	1.46	1.23-1.73	none			
21c_group	0.014	0.64	0.45-0.91				
Q3	0.035	0.89	0.80-0.99				
Q12	0.025	1.28	1.03-1.59				

model 3-2 (For children with 4 and more dmft (SCG))							
all kids (sub-model I)				only kids with brushing habits (sub-model II)			
Variables	<i>P</i>	OR	95% CI	Variables	<i>P</i>	OR	95% CI
age	0.000	1.90	1.59-2.27	age	0.000	1.92	1.49-2.48
Q5	0.000	0.58	0.45-0.75	21b_group	0.021	0.36	0.15-0.86
Q12	0.000	2.03	1.62-2.55	Q5	0.035	0.69	0.49-0.98
Q13	0.000	0.30	0.21-0.45	Q11	0.028	0.70	0.51-0.96
				Q12	0.000	2.48	1.76-3.51
				Q13	0.000	0.41	0.25-0.66

OR: odd rates; CI: confidence interval; NA: not applicable.

Supplementary Files

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